Ag-doped V_2O_5 thin film cathode prepared by pulsed laser ablation for rechargeable Li-ion batteries

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Research on all-solid state rechargeable thin film Li - batteries has received considerable attention recently. These rechargeable Li-batteries are potentially useful as power sources for computer-chip backups, sensors in micromechanics, hazard cards and other low power devices. Thin film Li-batteries with a lithium anode, an amorphous inorganic Li^+ ion-conducting electrolyte and different kind of cathode has been fabricated layer by layer using vacuum deposition techniques. In recent years pulsed laser deposition(PLD) has been used for the fabrication of thin film electrodes and has been successfully used to prepare $LiCoO_2$, $LiMn_2O_4$ and V_2O_5 thin films. Orthorhombic V_2O_5 is recognized as promising cathode materials for rechargeable Li-ion batteries. Ag- and Cu-doped V_2O_5 materials with high electronic conductivity and good reversibility have also been investigated to improve the electrochemical performance of V_2O_5 [1]. In this report we present thin films of Ag-doped and undoped V_2O_5 cathode materials prepared by pulsed laser deposition (PLD) method. V_2O_5 films with various doped Ag are deposited from a target with different Ag/V_2O_5 molar ratio (x) on a substrate at 300°C and 0.3 Torr O_2 ambient. XRD measurement shows that the Ag-doped V_2O_5 films deposited on a stainless steel substrate exhibits polycrystalline structure. The SEM micrograph of the Ag-doped V_2O_5 films shown in fig. 1 illustrates that the nanosized particles are less than 100 nm with a uniform distribution and are composed of V_2O_5 and Ag according to the EDX analysis. A cross-sectional micrograph indicates that the film has a fairly flat and dense surface. The electrochemical performance of the Ag-doped V_2O_5 is dependent on the Ag/V_2O_5 ratio (x) of the film, as shown in fig.2. The specific capacity of the Ag-doped V_2O_5 film increases with the increase of x and decreases with increasing the current density. The specific capacity of $Ag_{0.5}V_2O_5$ is found to be 396 mAh/g at a current density of 0.01 mA/cm^2, which is higher that that of the pure V_2O_5 film electrode (320mAh/g). Fig. 3 presents the cycle performance of the Ag-doped V_2O_5 and pure V_2O_5 film electrodes where the delivered capacity of film electrodes is obtained upon repetitive charge and discharge cycle at the C/4 rate. Although these Ag-doped film electrodes exhibit good cycle performance, $Ag_{0.3}V_2O_5$ cathode appears to be superior with a stable capacity of 250 mAh/g at 0.1 mA/cm^2. Our results show that the electrochemical properties of the Ag-doped V_2O_5 film electrodes prepared by PLD are excellent and better than that prepared by aerosol-like method [1].

[1] F. Coustier,J. hill, B. B. Owens, S. Passerini and W. H. Smyrl, J. Electrochemical Soc., **146**, 135 (1999).

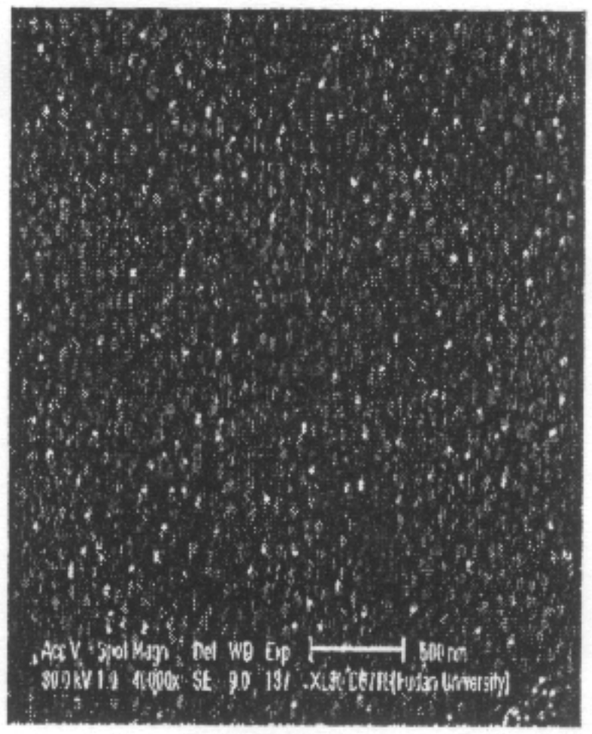

Fig. 1 SEM image of $Ag_{0.3}V_2O_5$

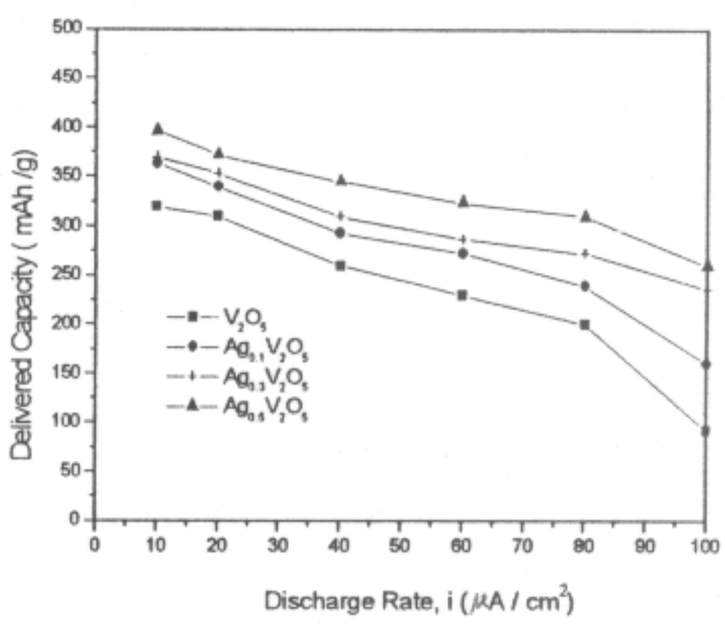

Fig.2 Delivered capacity vs discharge behavior o Ag-doped V_2O_5 cathodes. The voltage limits were 1.0and 4.0V.

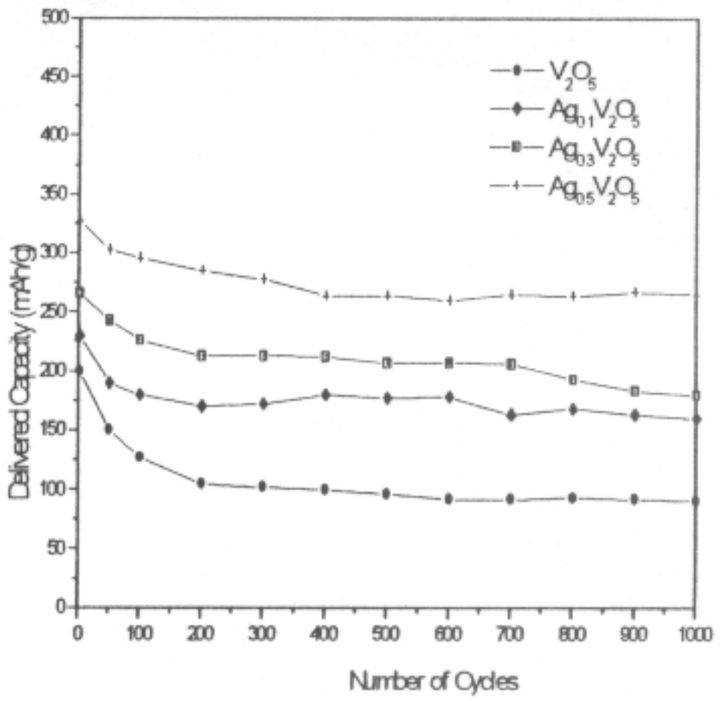

Fig. 3. Cycling performance (0.100mA/cm²) of Ag-dopedV_2O_5 cathode